Mark Scheme (Results)

January 2014

IAL Chemistry (WCH02/01)

Unit 2: Application of Core Principles of Chemistry

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January 2014
Publications Code IA037627

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A (multiple choice)

Question Number	Correct Answer	Reject	Mark
1	B		**1**

Question Number	Correct Answer	Reject	Mark
2	B		**1**

Question Number	Correct Answer	Reject	Mark
3	A		**1**

Question Number	Correct Answer	Reject	Mark
4	A		**1**

Question Number	Correct Answer	Reject	Mark
5	D		**1**

Question Number	Correct Answer	Reject	Mark
6	D		**1**

Question Number	Correct Answer	Reject	Mark
7	B		**1**

Question Number	Correct Answer	Reject	Mark
8	D		**1**

Question Number	Correct Answer	Reject	Mark
9	B		**1**

Question Number	Correct Answer	Reject	Mark
10	A		**1**

Question Number	Correct Answer	Reject	Mark
11	C		**1**

Question Number	Correct Answer	Reject	Mark
12	A		**1**

Question Number	Correct Answer	Reject	Mark
13	A		**1**

Question Number	Correct Answer	Reject	Mark
14	D		**1**

Question Number	Correct Answer	Reject	Mark
15	C		**1**

Question Number	Correct Answer	Reject	Mark
16	A		**1**

Question Number	Correct Answer	Reject	Mark
17	C		**1**

Question Number	Correct Answer	Reject	Mark
18	D		**1**

Question Number	Correct Answer	Reject	Mark
19	C		**1**

Question Number	Correct Answer	Reject	Mark
20	C		**1**

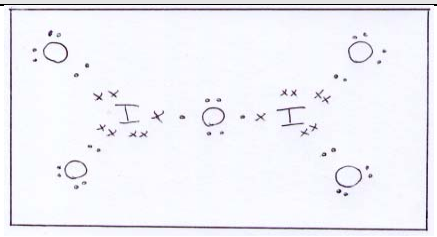
TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	(No because) The oxidation number of iodine in HIO_3 **and** I_2O_5 is **+5 / 5+ / V** OR The oxidation number **+5 / 5+ / V** remains the same.	Yes	**1**

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	To remove the water formed OR To prevent the 'back'/reverse reaction/to favour the right hand side/ to move the position of the equilibrium to the right/ to prevent I_2O_5 reacting with water OR To stop hydrolysis of iodine pentoxide	Water of hydration	**1**

Question Number	Acceptable Answers	Reject	Mark
21(a)(iii)	$I_2O_5 \rightarrow I_2 + 2½O_2$ Allow multiples/fractions Allow also the use of $\rightleftharpoons$. Ignore state symbols even if incorrect. Ignore temperatures.	Oxygen gas on both sides of the equation.	**1**

Question Number	Acceptable Answers	Reject	Mark
21(a)(iv)	 Double-bonded oxygens at the 4 corners, each with 2 lone pairs **(1)** Iodine to have 12 electrons and the central oxygen to be single-bonded with two lone pairs **(1)** Alternative diagrams with dative covalent bonds instead of double bonds to the oxygen, but then the oxygen would have three lone pairs, could be allowed for one mark. Allow one mark for correct diagram with all dots or all crosses Allow dots and crosses to be other way round, • for I and X for O. Lone pairs do not necessarily have to be clearly paired.		**2**

Question Number	Acceptable Answers	Reject	Mark
21(a)(v)	105° - 107° **(1)** Pyramidal **(1)** Ignore trigonal, or alternative spellings of, or triangular before pyramidal	Bipyramidal planar	**2**

Question Number	Acceptable Answers	Reject	Mark
	In (b) any units given must be correct. Penalise once only. **TE throughout**		
21(b)(i)	(0.01x 0.0216 =) 2.16 x 10^{-4}/0.000216 (mol)	2.2 x 10^{-4}/ 0.00022	**1**

Question Number	Acceptable Answers	Reject	Mark
	IGNORE SF except 1SF. Penalise once only in (b)(ii), (iv), (v) and (vii).		
21(b)(ii)	4.32 x 10^{-4}/0.000432 (mol) Allow 4.3 x 10^{-4}/0.00043 (mol) Allow TE from (b)(i) x 2 Allow any SF except 1		**1**

Question Number	Acceptable Answers	Reject	Mark
21(b)(iii)	(0.04 x 0.02 =) 8.0 x 10^{-4}/0.00080 (mol) **Allow 1SF here only.**		**1**

Question Number	Acceptable Answers	Reject	Mark
21(b)(iv)	(8.0 x 10^{-4} – 4.32 x 10^{-4} =) 3.68 x 10^{-4} (mol) Allow 3.7 x 10^{-4}/0.00037 Allow TE from (b)(iii) ans – (b)(ii) ans Allow any SF except 1		**1**

Question Number	Acceptable Answers	Reject	Mark
21(b)(v)	1.84 x 10^{-4}/0.000184 (mol) Allow 1.85 x 10^{-4}/0.000185/ 1.8 x 10^{-4}/0.00018 Allow TE from (b)(iv) ans ÷ 2 Allow any SF except 1		**1**

Question Number	Acceptable Answers	Reject	Mark
21(b)(vi)	$I_2O_5 + 5CO \rightarrow I_2 + 5CO_2$ Allow multiples/fractions Ignore state symbols even if incorrect		**1**

Question Number	Acceptable Answers	Reject	Mark
21(b)(vii)	$(1.84 \times 10^{-4}) \times 5$ **(1)** $\times 24 = 2.208 \times 10^{-2}/0.02208$ (dm^3) **(1)** Allow TE from (b)(v) and or b(vi) Allow any SF except 1 Correct answer no working **(2)** Allow answer in cm^3 but the unit must be given eg 22.08 cm^3		**2**

Question Number	Acceptable Answers	Reject	Mark
21(b)(viii)	Repeat the experiment (to get concordant titres)/ Divide solution into (equal) samples before carrying out titration/ divide the gas into (equal) samples before carrying out titration. IGNORE: Use a larger volume of gas/Use a weaker concentration of thiosulfate /Use more accurate equipment	Just 'repeat the titration'	**1**

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	(cars have a) Catalytic converter ALLOW Other suitable modifications which refer to more efficient combustion OR Use of hydrogen as a fuel or solar power Or use of electric cars.	Just 'car converted to run on other fuels which contain carbon' Just 'catalyst' Just 'more fuel efficient cars'	**1**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii)	The amount of CO_2 produced (on combustion) is equal to the amount of CO_2 absorbed (during photosynthesis) **(1)** Biofuel/ any suitable biofuel example such as bioethanol/ biodiesel/ suitable description of source such as "ethanol produced from sugar" **(1)** ALLOW Hydrogen produced using **renewable** resources Stand alone marks	Just 'carbon' Just 'Ethanol' Fuel cells	**2**

TOTAL FOR QUESTION 21 = 19 MARKS

Question Number	Acceptable Answers	Reject	Mark
22 (a)	(Fe_2O_3 + 2Al →) Al_2O_3 + 2Fe Allow products in either order.	Fe_2 / Fe^{2+} / Fe(II)	**1**

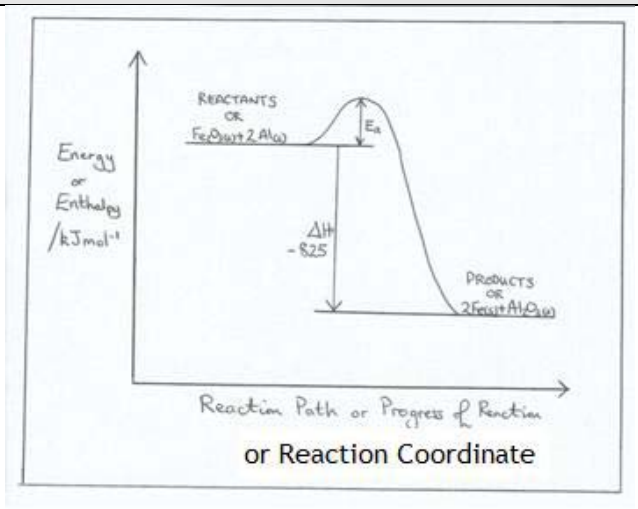
Question Number	Acceptable Answers	Reject	Mark
22 (b)	(use of) 159.6 (g mol^{-1}) **(1)** (34.0÷159.6 =) 0.213 (mol) **(1)** (0.213 x 2 x 27 =) 11.502/11.50/11.5 (g) **(1)** Answer alone scores 3 If units are given, they must be correct. Ignore sf except 1 ALLOW (use of 56 for Fe so Fe_2O_3 =) 160 (g mol^{-1}) **(1)** (34.0÷160 =) 0.2125 (mol) **(1)** (0.2125 x 2 x 27 =) 11.475/11.48/11.5 (g) **(1)**		**3**

Question Number	Acceptable Answers	Reject	Mark
22(c)	Heat (in an oven)/heat (over Bunsen burner)/ heat (to constant mass).	Just 'desiccator' Temp <100°C Burn/warm Drying agents Leave to dry	**1**

Question Number	Acceptable Answers	Reject	Mark
22(d)	To ensure complete reaction /(solids) so must be well-mixed for reactants to come into physical contact/ more surface area in contact. ALLOW More collisions of particles IGNORE Make it easier for the reactants to mix	Just 'to increase the rate of reaction' Just 'both reactants are present in solid form' Any reference to the generation of energy.	**1**

Question Number	Acceptable Answers	Reject	Mark
22(e)(i)	White light/white powder/ White smoke / White flame.	Just 'light' 'bright light' White ppt Colourless flame	**1**

Question Number	Acceptable Answers	Reject	Mark
22(e)(ii)	Magnesium oxide/MgO Allow magnesium nitride/Mg_3N_2 Allow equation to produce MgO, e.g. $2Mg + O_2 \rightarrow 2MgO$ If name and formula given then both must be correct Ignore state symbols.		**1**

Question Number	Acceptable Answers	Reject	Mark
22(e)(iii)	 Labelled y axis (kJ mol^{-1}) The x axis need not be labelled but if labelled must be correct **(1)** If units are given on the axis they must be correct Labelled reactants above products **(1)** Exothermic change of -825 shown **(1)** Activation energy **(1)**	Enthalpy **change** / heat Time on the 'x' axis Mg/O_2	**4**

Question Number	Acceptable Answers	Reject	Mark
22(e)(iv)	(provides the) activation energy/ (provides the) energy for the reaction to occur/heat for the reaction to occur/ overcome the energy barrier Allow this to be written on the diagram	Decreases E_a Just 'to initiate reaction' Acts as a catalyst	**1**

Question Number	Acceptable Answers	Reject	Mark
22(e)(v)	(Chemically) changed by the reaction/ (it is) changed into MgO/ Used up (by the reaction) Allow doesn't lower activation energy	Just 'it reacts' Provides alternative routes or pathway. Does not speed up the reaction Just 'it takes part in the reaction'.	**1**

Question Number	Acceptable Answers	Reject	Mark
22(e)(vi)	(Once reaction is started it provides) enough energy to be self-sustaining/ energy only needed at the start as the reaction is exothermic	Chain Reaction Just 'highly exothermic reaction'	**1**

Question Number	Acceptable Answers	Reject	Mark
22(f)	It may ignite at any time/delay in the reaction/molten metal may be ejected	Just 'explosion' Flammable/ fire	**1**

Question Number	Acceptable Answers	Reject	Mark
22(g)	The iron is melted/molten/liquid (and joins the two pieces of metal/railway line)	Melt Aluminium Just 'melt the metal' Just 'melt the railway lines'	**1**

Question Number	Acceptable Answers	Reject	Mark
22 (h)	Aluminium is readily available/abundant/cheap/easy to handle/easy to store/Al_2O_3 has a low density so floats (and avoids contaminating the weld) OR Reverse argument/other metals may not react and release enough heat (to melt the iron)/other metals are difficult to store	Al does not corrode Other metals are too exothermic.	**1**

TOTAL FOR QUESTION 22 =18 MARKS
TOTAL FOR SECTION B = 37 MARKS

Section C

Question Number	Acceptable Answers	Reject	Mark
23(a)	$C_6H_8O_3$ Allow elements in any order.	Any other answers	**1**

Question Number	Acceptable Answers	Reject	Mark
23(b)	(Secondary) alcohol/Hydroxyl OR Alkene/Carbon-Carbon double bond OR Enol/ether	C-OH/ Just 'OH Group' Primary alcohol C=C Just 'double bond' Ester	**1**

Question Number	Acceptable Answers	Reject	Mark
23(c)(i)	ROH + Na $\rightarrow RO^{(-)}Na^{(+)}$ + ½H_2 **(1)** Allow multiples Ignore state symbols even if incorrect Effervescence/Fizzing/Bubbles OR Sodium dissolves/disappears/ decreases in size OR White solid forms **(1)** Stand alone marks	RNaO White ppt	**2**

Question Number	Acceptable Answers	Reject	Mark
23(c)(ii)	ROH + $PCl_5 \rightarrow$RCl + $POCl_3$ + HCl **(1)** Ignore state symbols even if incorrect Steamy /misty / white **and** fumes/gas**(1)** Stand alone marks Allow PCl_3O	 White smoke	**2**

Question Number	Acceptable Answers	Reject	Mark
23(c)(iii)	(HCl poses the greater risk – No credit but must be stated for the second mark) (because it is)toxic/corrosive/poisonous/ reference damage to skin **(1)** Not enough hydrogen produced/ hydrogen produced only slowly (so won't catch fire) **(1)**	Harmful/ ozone depletion/ Flammable Just 'acidic' Just 'dangerous'	**2**

Question Number	Acceptable Answers	Reject	Mark
23(d)(i)	Agent: sodium dichromate((VI)) / $Na_2Cr_2O_7$/ potassium dichromate((VI))/ $K_2Cr_2O_7$ **(1)** sulfuric acid/H_2SO_4 **(1)** If name and formula are given, both must be correct. Conditions: Distillation **(1)** Allow 'Fractional distillation' Acidified dichromate/ H^+ and $Cr_2O_7^{2-}$ scores 1 mark Allow the acid as a reagent or as a condition. Acid can be conc. or dilute	$KMnO_4$ Any other acids Reflux/ Just 'heat'	**3**

Question Number	Acceptable Answers	Reject	Mark
***23(d)(ii)**	(infrared radiation causes) stretching/ bending/changes in bond polarity/bond vibration **(1)** different bonds absorb different IR (frequencies/wavelength/wavenumber)/ different peaks for different groups **(1)** compare absorption with database / data booklet **(1)**	Molecular vibration Bonds broken	**3**

Question Number	Acceptable Answers	Reject	Mark
***23(e)**	Point 1: (Alkanes) London Forces/ Dispersion forces/van der Waals' forces **(1)** Point 2: (Arises) – instantaneous dipole/momentary imbalance in electron density **(1)** Point 3: which **induces** dipole in adjacent molecule (and results in attraction) / description of **induction** **(1)** Ignore reference to atoms/molecules _____ Point 4: (Alcohols) Hydrogen bonds **(1)** Point 5: (Arises) – oxygen's higher electronegativity creates dipole/large difference in electronegativity **(1)** Point 6: Bond is attraction between (lone pair of electrons on) O of one molecule and H of **another** molecule **(1)** _____ Point 7: London forces are weaker than hydrogen bonds **(1)** Allow "alkanes intermolecular force weaker (than that of alcohols)" for point 7	Just 'Id-Id' Any other forces in combination Any reference to permanent dipoles loses points 2 & 3 London Forces	**7**

Question Number	Acceptable Answers	Reject	Mark
23(f)	Unique fragmentation/ different fragmentation/ different peak pattern	Just 'different masses'	**1**

Question Number	Acceptable Answers	Reject	Mark
23(g)	Polymers have low volatility/ do not bind to receptors in nose/ Polymers do not have an aroma/ Polymer formation does not involve the 'aroma' molecules/ The chemicals causing the aroma are not affected (by the enzyme)		**1**

TOTAL FOR SECTION C = 23 MARKS

TOTAL FOR PAPER = 80 MARKS